make its adoption none the less imperative. The true line of work to be pursued is, first, to invoke the operation before the strength of the patient is too much exhausted for the unavoidable shock of the operation to be borne, and, second, to so improve the technique of the operation as to reduce its hazards as much as possible.

LEWIS S. PILCHER.

ON THE PRESENT STATE OF KNOWLEDGE IN BACTERIAL SCIENCE IN ITS SURGICAL RELATIONS.

(Continued from Page 155.)

B. OSTEOMYELITIS.

Acute osteomyelitis has of late years been considered by many surgeons and pathologists to be an infectious disease of a specific nature. Rosenbach, of Goettingen, working on the subject of surgical infectious diseases, and publishing his researches in the *Deutsche Zeitschrift für Chirurgie*, advanced this opinion in the year 1878[1], while Kocher, of Berne, believed the infection to be simply a septic or a putrid one.[2]

Pasteur, Ogston and other observers had found micrococci in osteomyelitic pus, and Koch had photographed them; still no evidence of their specific nature was procured.

Considerable interest, therefore, was awakened by a publication of Geheimrath Struck, the director of the Imperial Board of Health, which appeared under the title of a preliminary communication in No. 46 of the *Deutsche Medicinische Wochenschrift* in November, 1883—during the time that Koch was absent on behalf of the cholera commission—and which contained the announcement that Dr. Becker, one of Koch's assistants, had succeeded in cultivating the specific micrococcus of osteomyelitis. By inoculating potato-soils and soils prepared with peptonized and gelatinized infusion of meat and with sheep's blood-serum, with pus from five cases of acute osteomyelitis, Becker succeeded in obtaining certain orange-colored cultures in a few days; and after some further days the gelatine soils became liquefied, and an orange colored sediment could be observed in the test-tubes. An odor of "spoilt starch paste" was noticeable after exposure to the air. The micrococcus resembled Koch's diagram in size and appearance.

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[1] Vol. X, pp. 369 and 492. "Experimentell-klin. Studie über die Ætiologie der Osteomyelitis.

[2] L. c., vol. XI, p. 87, and Reports 7 Congress d. Ges für Chir. 1878. II Part, p. 1.

Inoculations performed on animals with considerable quantities of the culture material proved highly toxic in their effects. But when the bones were subjected to injuries or subcutaneous fractures a few days before the micrococci were injected, tumor of the injured limbs was first observed and emaciation and death ensued after twelve or fourteen days. A great amount of pus was always found at the seat of the injury, the periosteum was detached from the bone, and the medullary cavity was filled with pus. In three cases embolisms containing micrococci were found in the lungs and kidneys.

Culture experiments performed with the pus and blood yielded pure cultures identical with the first ones. This result taken together with some experiments conducted by E. Hahn[1] who had also succeeded in producing from osteomyelitic pus orange-colored cultures, which in their growth liquefied the gelatine soils, tended to confirm the theories of the specific nature of the disease.

In the following April a paper was published by F. Krause, an assistant at the surgical Clinic of Halle,[2] containing accounts of experiments dating back to May, 1883, which, on the whole, confirmed Becker's results. Krause inoculated serum soils, peptonized extract-of-meat, gelatine, and isinglass soils prepared with extract of meat, with pus from unopened osteomyelitic abscesses, and in eight cases obtained the orange-colored micrococcus; in one case, however, he obtained two kinds, one yielding an orange, the other a white growth; but in this latter case the abscess had broken through the skin. The same orange-colored organisms were also found in the effusions in the joints. Cultures in sterilized milk resulted in the coagulation and fermentation of the milk.

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[1] Referred to in an editorial of the *Fortschritte der Medicin*, Vol. I, beil. 209. but not otherwise published.

[2] "Ueber einen bei der acut. infec. Osteomyelitis des Menschen vorkommenden Micrococcus." Fortschr. der Med. Vol. II. 1884. P. 221.

For injections he used the liquefied gelatine of at least a sixth generation diluted one-half with sterilized water. Larger quantities injected into the abdomen caused peritonitis. Intra-venous injections were performed upon eighteen rabbits and seven guinea pigs, both with and without preceding injuries to the bones; localization in the joints resulted, and foci in the kidneys were always present. In seven out of fifteen cases abscess occurred at the seat of fracture, and in these cases the pus again yielded pure cultures. On the other hand putrid substances failed to produce suppuration of the bone-marrow, though they caused abscesses; neither could the peculiar orange-colored micrococcus be obtained from these latter abscesses by culture experiments,

Krause, however, concludes, in opposition to Becker, that the analogy existing between these experiments and the acute osteomyelitis occurring in man is imperfect and that the whole affection is quite a different one in each case, the artificial infection more closely resembling pyæmia.. He concedes, however, that the described micrococcus is highly pathogenic in character and of great vitality.

Krause, furthermore, found the same orange-colored micro-organisms in three cases of carbuncle of the neck in man, and with it was able to produce the same joint and kidney affections in five rabbits and two guinea pigs, which he injected with it, as in his experiments with the first-mentioned micrococcus, and in one case out of five, in which he had previously caused subcutaneous fracture of a bone, he even obtained an abscess at the seat of the fracture, and purulent infiltration of the bone-marrow. In other suppurations in man, however, he did not find the orange colored coccus.

This is of some interest, as Pasteur (as Rosenbach remarks) had previously identified the micrococci of carbuncle with those of osteomyelitis, and Garré subsequently, as will be mentioned further on, was led to the same conclusion.

The subject, however, owes its present aspect principally to Rosenbach's later observations and experiments.

This author published a note early in the year 1884.[1] anticipating his later communications,[1] in which he again called attention to the fact that he had been able to obtain affections resembling acute osteomyelitis, even to the necrosis of bone, by injecting the organisms of lactic fermentation and others into the animal system, but only after injuries done to the bone, and reminded his readers that Kocher had had similar results with putrid matter. These experiments now appeared in a different light. For, on the other hand, he had, more recently, been able, with the help of Koch's methods, to obtain cultivations of the orange-colored micrococcus from all manner of suppurative inflammations. He cultivated it seventeen times out of thirty-five unopened abscesses; he found it twice in five cases of empyema, twice in two cases of furunculus, three times in five cases of pyæmia, and twice in four septic affections.

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[1] "Vorlaufige Mittheilung über die die acute Osteomyelitis des Menschen erzeugenden Micro-organismen." Centralbl. für Chir. 1884. P. 65.

He, moreover, examined fifteen cases of osteomyelitis, and found the orange-colored micro-organism fourteen times; twelve times this alone was present, once a coccus growing as torula, and once a white micrococcus was found as well, which he names *streptococcus pyogenes* and *staphylococcus pyogenes albus* respectively. In one case of osteomyelitis only the latter was found, and not the orange-colored one at all.

Injections made with either of the micro-organisms found always resulted in phlegmons and abscesses. Rosenbach therefore concluded that the so-called specific micrococcus of osteomyelitis was nothing else than one of the eight kinds of organisms which he had found in common pus.

He gives the description of the three kinds of organisms found in osteomyelitis in the following manner, the first one here mentioned being Becker's osteomyelitis-micrococcus:

Staphylococcus pyogenes aureus—Grows on Japanese isinglass-soil prepared with infusion of meat and peptonized, at a temperature of 30° to 37° C. In twenty-four hours slide-cultures show slightly opaque, at first light-yellowish, later on more marked orange-colored lines, which subsequently grow broader, though not deeper, and show lateral facets. Microscopically examined the lines consist of rows of very small absolutely spherical micrococci, lying closely together. Their effect on rabbits is deleterious. They do not possess putrefactive action.

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[1] "Micro-organismen bei den Wundinfections Krankheiten des Menschen." Wiesbaden. 1884.

Staphylococcus pyogenes albus—Grows on the same soil luxuriously in opaque white colonies. Microscopically these are not to be distinguished from the former.

Streptococcus pyogenes—Grows slowly on peptonized infusion-of-meat-gelatine-soils in the form of whitish, somewhat opaque, round points, resembling particles of sand. On infusion-of-meat-soils prepared with agar-agar and peptonized, the organism grows more rapidly in round dots resembling pins' heads. In their further development the colonies appear higher in the centre, and here of a brownish color, growing lower towards the periphery and rising again at the outer edge, so as to form a thick, wavy, spotted marginal ridge. Viewed through the microscope they resemble Fehleisen's specific micrococci of erysipelas. Rosenbach's later publications are the same in substance, although detailed at greater length, while a later communication of Becker has not appeared.

The latest publication on this subject is by Garré of Bâle, who found both the yellow and the white varieties of micrococci in osteomyelitic pus, cultivating them on 3 per cent peptonized gelatine with infusion of meat, on 1 per cent agar-agar and on blood-serum soils.

He was also able to obtain cultures of these same two varieties from the blood of three of the patients, two of whom had passed the acute stage of the disease.

He therefore believes that these micro-organisms course in the blood as long as fever is present.

According to this author there is, therefore, at present, little doubt but that the two varieties of micrococci, the *staphylococcus pyogenes aureus* and *albus*, play an active part in the causation of acute osteomyelitis, although he allows that, until it can be proved that these micro-organisms occasion acute osteomyelitis in man, and without previous injury to bones, some obscurity must attach to the etiology of the disease, and particularly to the manner in which the infectious agents enter the system.

On the other hand it is proved, as far as the present state of bacterial science goes, that there is no specific osteomyelitic micro-organism other than those found in a number of other inflammatory processes connected with suppuration, viz., the *staphylococcus pyogenes.*

In order to satisfy himself that the micro-organisms of osteomyelitis possessed the same action as those other ones found in phlegmons, the author inoculated himself with pure cultures obtained from his osteomyelitis cases. Twice he introduced small quantities of culture-gelatine into cuts made for the purpose in his finger, and also applied a large quantity to the healthy skin of his arm by inunction. The first experiments resulted in slight phlegmonous inflammations; the latter procedure, however, caused a large and painful carbuncle of three weeks' duration. In these experiments, too, the pus again yielded pure cultures of the original form of micrococcus, *staph. pyog. aur.*

More recently Passet has succeeded in differentiating three distinct varieties of the *staphylococcus*, which differ mainly in the color of the colonies, and which he terms respectively, *aureus*, *albus* and *citreus*. But whether the latter is present in the pus formed in acute osteomyelitis has not yet been investigated. W. W. VANARSDALE.

ON TRANSFUSION AND REINFUSION OF BLOOD.

The recent practical communication by Dr. John Duncan, of Edinburgh, in the British Medical Journal, of Jan. 30, 1886, on the subject of Reinfusion of Blood in Primary and other Amputations, is deserving of careful consideration. Notwithstanding the positive statements of some (Bergmann, 1883; Mikulicz, 1884) that all that can be effected by the operation of transfusion of blood can be accomplished by the simpler means of infusing into the veins a solution of common salt, upon the hypothesis that what was required was to fill the elastic tubes of the vascular system with a certain amount of fluid. not necessarily blood, nevertheless the experience of many observers accords with the opinion expressed by Duncan, that the benefit from these saline injections is but temporary. For a time the conclusions of Köhler as to the dangers of ferment intoxication resulting from transfusions of defibrinated blood, strongly indorsed by Bergmann, have nevertheless